



Installation manual

Medium-voltage transformers

Pólux®

Congratulations!

You have purchased a medium-voltage dry-type transformer developed and manufactured by Pólux Indústria Eletromecânica LTDA.

To ensure optimal performance and equipment lifespan, carefully read the instructions in this manual. Following the guidelines presented here contributes to the safe operation of the transformer and helps prevent wear or damage resulting from improper installation, operation, or maintenance.

It is also recommended to consult the standards and requirements for electrical installations established by local utility companies.

This manual aims to provide all the necessary information for the installation, operation, preservation, and maintenance of Pólux medium-voltage dry-type transformers. Each piece of equipment is designed and manufactured to meet the specific application needs of our customers, guaranteeing quality, safety, and reliability. If you have any questions or require technical support, please contact our team. We will be happy to assist you!



Summary

1. Safety warning	5
2. Introduction	5
3. Basic Instructions	6
3.1. General Instructions	6
3.2. Supply	7
3.2.1. Place of receipt	7
3.2.2. Receiving inspection	7
3.2.3. Unloading and handling	8
3.3. Storage	10
4. Installation of dry-type transformers	11
4.1. General considerations	11
4.2. Special conditions	18
4.2.1. Operating altitude	19
4.3. Basic installation requirement	20
4.4. Blocking airflow from the protective enclosure	22
4.5. Noise level	23
4.6. Distances required for operation	24
4.6.1. Busbar connection	26
5. Protection and control system	26
5.1. Surge arresters	26
5.2. Temperature monitoring	27
6. Commissioning	28
6.1. List of instruments	29
6.2. List of tests and verifications	29
6.3. Acceptance criteria	30
6.4. Painting	30

6.4.1. Visual inspection	30
6.4.2. Surface preparation and painting	31
7. Energization	32
8. Putting the transformer into operation	34
9. Derivation/Voltage Change	34
10. Maintenance	34
10.1. Maintenance Items	35
11. Cleaning	37
12. Special protection class for dry-type transformers	38
12. 1. Operation of the fans and exhausters	39
12.2. Cleaning the air intake and exhaust ventilation filters	39
13. Safety and environment	40
14. Warranty Terms	41
14.1 The following equipment is not covered by the warranty	42

1. Safety warning

- Do not lift or move the transformer without proper equipment and experienced personnel;
- Do not unload the transformer until a complete inspection has been completed;
- Do not adjust or remove any accessories or covers while the transformer is powered on;
- The transformer must be de-energized and all terminals grounded before any maintenance.
- Make sure all connections are complete and tight before energizing the transformer;
- Do not alter the connections while the transformer is energized.

2. Introduction

This manual aims to provide necessary instructions for users handling, transporting, storing, installing, and maintaining Pólux dry-type transformers. Following these instructions will ensure optimal equipment performance, as well as the electrical characteristics for which it was designed and specified by the customer.

This manual covers single-phase and three-phase transformers, installed with or without enclosures, establishing the limiting factors for their optimal performance. The information contained herein describes the inspection, proper installation, and maintenance of dry-type transformers.

Pólux transformers are designed and manufactured in strict accordance with the standards in effect at the time of their construction. For further clarification, it is recommended to read the following standards:

- NBR 5356-11: Dry-Type Power Transformers;
- NBR 5356-7: Power Transformers;
- NBR 13297: Receiving, installation and maintenance of dry-type power transformers – Procedures;
- IEC 60076-5: Power transformers - Part 5: Ability to withstand short circuit
- IEC 60076-11: Dry-type Power Transformers;
- IEC 60076-12: Loading Guide for Dry-type Power Transformers.

To ensure the correct installation and operation of the transformer, it is essential that the procedures described in this manual and in the aforementioned standards be carried out by a qualified professional with knowledge of the applicable technical and safety standards, ensuring a proper and safe installation.

3. Basic Instructions

3.1. General Instructions

Safety in electrical installations is a non-negotiable commitment. It is essential that all workers involved receive continuous and specific training on technical standards and safety procedures in order to prevent accidents. The technical manager must ensure that the work environment complies with current regulations, with adequate personal and collective protective equipment and clear emergency signage.

Furthermore, it is essential that the team is aware of the risks inherent in working with electricity and that they are instructed to rigorously follow work procedures. The installation, operation, and maintenance of transformers must be carried out exclusively by qualified and experienced professionals.

3.2. Supply

After undergoing rigorous testing and being cleared for transport, the transformers are packed in treated wooden crates, specially designed to withstand impacts and vibrations. This packaging, in accordance with current technical standards, guarantees the protection of the equipment against moisture, dust, and other external agents during transport, ensuring its operational integrity until its final destination.

3.2.1. Place of receipt

Transformer unloading should preferably be carried out on its permanent base. If a temporary location is necessary, it must guarantee safety conditions, load distribution, and protection of the equipment against inclement weather.

3.2.2. Receiving inspection

In order to guarantee the integrity of the equipment, a thorough inspection is mandatory before unloading. This inspection must be carried out while the equipment is still in transit and must include checking the condition of the packaging, verifying the information on the identification plate against the documentation, visually inspecting all components for cracks, scratches or dents, and counting and verifying all accessories and connections. It is essential to document all stages of the inspection with photographs.

If any non-conformities are identified, the quality control procedures must be activated immediately for proper analysis and corrective action, as follows:

- Notify Pollux immediately;

- Make a detailed note of the deviation on the back of the transport document, as per the Warranty Terms;
- Send an email to Pólux technical support containing photos of the equipment still on the truck bed, photos of any damage, and the equipment's serial number.

3.2.3. Unloading and handling

Handling transformers requires specific procedures to ensure the safety and integrity of the equipment. All unloading, lifting, and moving operations must be performed by qualified and experienced personnel. The transformer must be protected from moisture and impacts during all stages of handling.

Lifting must be carried out exclusively from the anchor points indicated in the technical drawing, using appropriate lifting equipment, such as load slings, with sufficient load capacity and in perfect condition. Dragging must be done on suitable support devices, such as wheels or drag bases, ensuring the stability of the equipment and avoiding the risk of tipping over.

The transformer can only be moved with a forklift when it has a pallet compatible with the operation. During forklift handling, the transformer cannot be exposed to an angle of inclination greater than 10°, due to the risk of tipping, and it is necessary to use a forklift compatible with the weight and dimensions of the transformer. Attention must be paid to the positioning of the transformer in relation to the forklift in order to avoid causing damage to the transformer.

Important: When lifting transformers equipped with protective enclosures, the following precautions must be taken:

- The cover on the roof of the enclosure must be removed, and the transformer must always be lifted by the eyelets on the upper beams of

the transformer (inside the protective enclosure). If necessary, the entire roof of the enclosure may be removed.

- Prevent fasteners, tools, particles, or debris from falling onto the active part of the transformer, as this could cause irreversible damage.
- The process of removing the covers to access the lifting lugs and subsequent lifting must be done carefully to avoid damage to the enclosure plates.

Figure 1: Demonstration of transformer lifting.



Source: Pólux Indústria Eletromecânica Ltda

Note: The protective enclosure is of utmost importance for the transformer's operation; therefore, after moving the item to its final location using the lifting lugs, it is necessary to replace the top cover that was removed.

In some cases, the protective box will have eyelets on the front and back. These eyelets are for exclusive use during the transport of the item, as they are used to increase the stability of the transformer during transit. These eyelets must never be used to lift the item, as this poses a risk of tipping and damage. Figure 2 highlights these eyelets.

If the transformer is damaged during lifting by the transport eyelets, Pólux will not provide a warranty, as this confirms misuse of the equipment.

Figure 2: Detail of the eyelets used only in transport.



Source: Pólux Indústria Eletromecânica Ltda

3.3. Storage

Transformers should be stored in a controlled environment with relative humidity below 60% and ambient temperature between 5°C and 35°C. The

original packaging must be retained to ensure protection of the insulation against moisture, dust, and contaminants. The use of silica gel packets on parts such as the core, windings, and bottom of the enclosure is recommended.

Components and accessories, when removed from the transformer for transport or storage, must be stored in suitable locations.

After the storage period, the dry-type transformer can be energized, following the instructions contained in this manual.

We emphasize that the responsibility for storing the delivered equipment at the location designated by the customer rests with the customer. All dry-type transformer materials must be stored in a sheltered and dry location.

4. Installation of dry-type transformers

4.1. General considerations

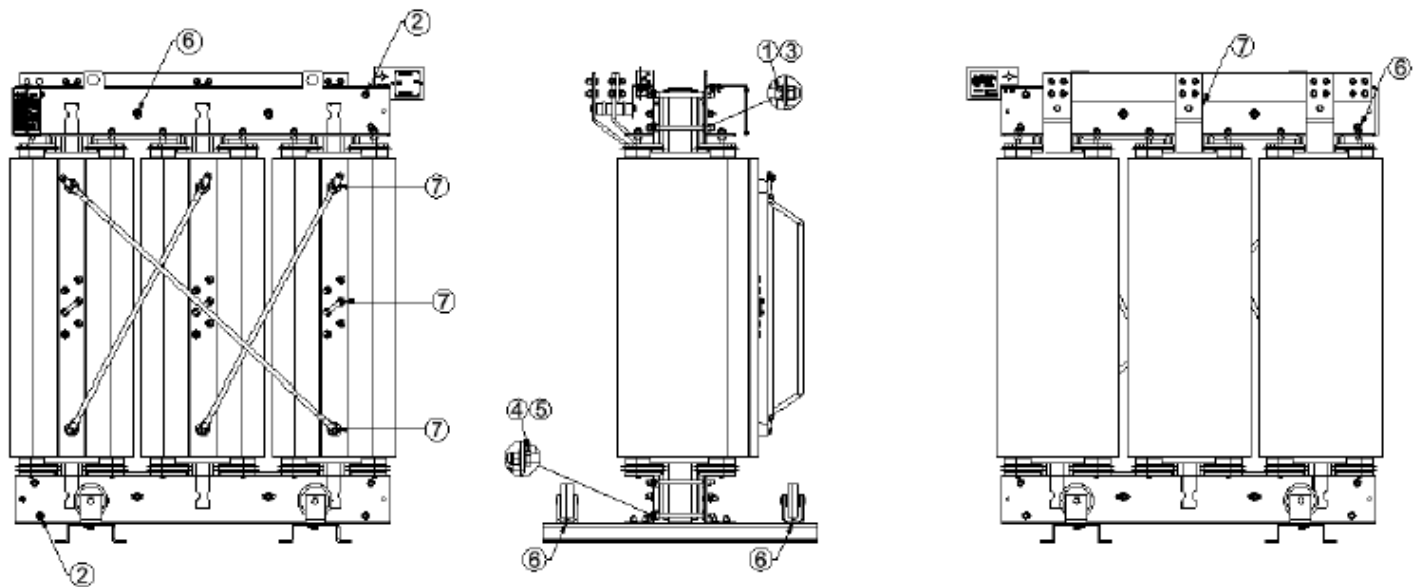
Pólux dry-type transformers are designed to operate at a maximum ambient temperature of 40°C and a maximum altitude of 1000 meters above sea level, unless otherwise specified. Installation should be in a sheltered location with adequate ventilation for proper cooling. Dry-type transformers must not be directly exposed to the elements except in cases requiring special protection ratings.

Before any action is taken to install the transformer, the availability of qualified personnel, as well as appropriate equipment and tools, must be verified. The transformer manufacturer is not responsible for its installation unless this is expressly stated in the purchase order.

Before installing the transformer, a verification must be carried out, including at least the following items:

- A thorough visual inspection to ensure that no damage occurred during the handling of the transformer;
- Checking that the base is properly level;
- Properly securing the transformer to its final base;
- Confirmation that the nameplate data is compatible with the equipment's technical specifications;
- Evaluation of the transformer grounding connections;
- Retighten all connections (Figure 3):
 1. Loosen the inner nuts of the upper horizontal tie rods;
 2. Retighten the nuts on the vertical tie rods in the upper and lower reinforcement bars;
 3. Retighten the outer and inner nuts of the upper horizontal tie rods;
 4. Loosen the inner nuts of the lower horizontal tie rods;
 5. Retighten the outer and inner nuts of the lower horizontal tie rods;
 6. Retighten the remaining mechanical connections (protective housing, wheels, grounding, etc.);
 7. Retighten all electrical connections.

Figure 3: Retightening of connections.



Source: Pólux Indústria Eletromecânica Ltda

The input and output terminals of the Pólux dry-type transformer are made of copper, aluminum, or brass screws and are located at the ends of the coils. All terminations must be flexible to avoid mechanical stress. These terminations can support considerable conductor weights, but long distances without supports should be avoided. Cables or busbars must be correctly sized and connections properly tightened to prevent overheating. All Pólux dry-type transformers have terminal identification in accordance with applicable standards. Before connecting the terminals to their respective circuits, the following procedures must be followed to prepare their surfaces:

- Protect the transformer so that cleaning residue does not settle on the coils and other parts;
- Apply industrial petroleum jelly or a zinc-rich antioxidant compound to the conductive parts immediately after surface cleaning. Cleaning tin-plated copper connectors should follow the same procedure, taking care not to remove the finishing material;

- In aluminum-copper connections, a copper-aluminum alloy plate (bimetallic element) may be used, but it is not supplied with the equipment unless requested. All connection accessories: screws, nuts, flat, spring or conical washers, must be made of steel and protected against corrosion (galvanized, cadmium plated, etc.);
- To transmit the correct screw pressure to the contact surface, conical washers should be used that do not deform and can accommodate volume variations due to temperature fluctuations;
- The bolts should preferably be tightened using a dynamometer or torque limiting wrench, ensuring even pressure distribution and proper electrical contact;



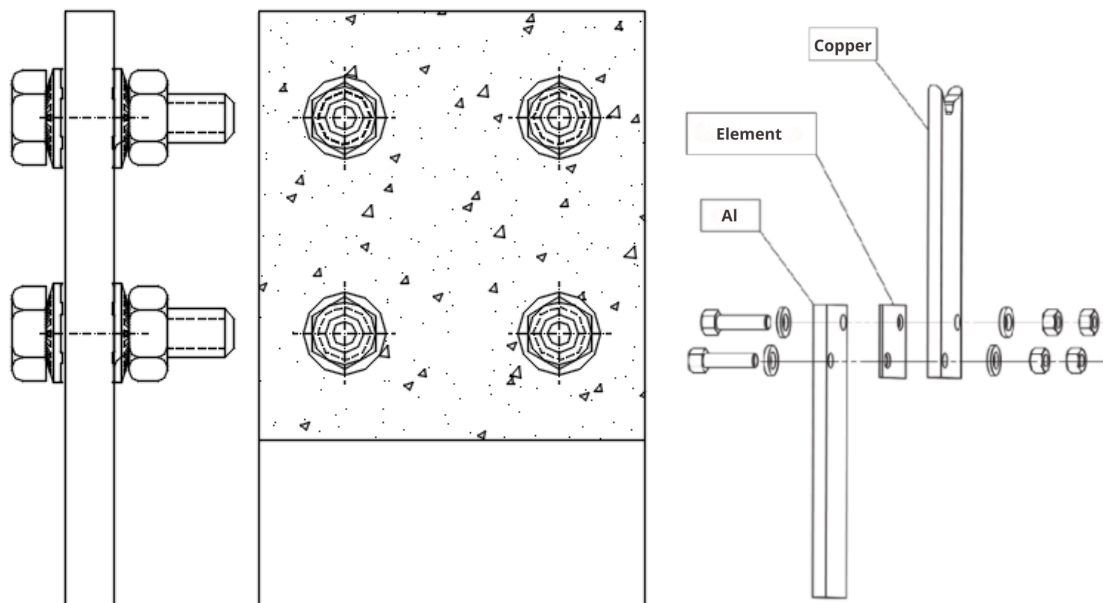
- After the first 24 hours of operation under load, it is recommended to inspect all connections to detect any overheating resulting from loose connections or poorly crimped terminals on the connecting cable. Repeat inspection every 12 months;
- The recommended torques are shown in Table 1 below, for both bolted and compression electrical connections:

Table 1: Nominal tightening torques.

Type of electrical connections (check if necessary)	Torque - Nominal Tightening [Nm]				
	M6	M8	M10	M12	M16
Hex Head Bolts (Class 8.8)	8	22	43	75	183
Brass Screws	8	22	35	50	120
304 Stainless Steel Screws	6,2	15	30	52	130

Source: NBR

Figure 4 - Type of terminals available for connecting the transformer terminals with a bimetallic element.



Fonte: Pólux Indústria Eletromecânica LTDA



To even out any potential settling, Pólux recommends retightening the screws a few weeks after installation. When retightening, the torque applied should not exceed the torque applied during assembly.

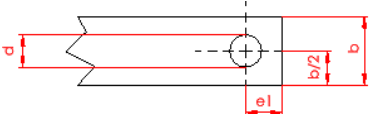
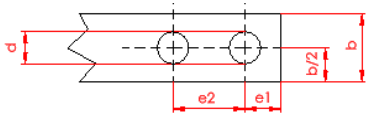
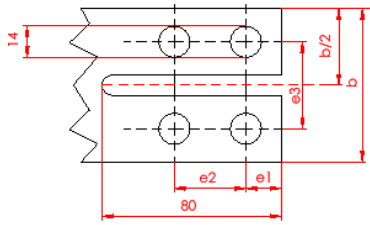
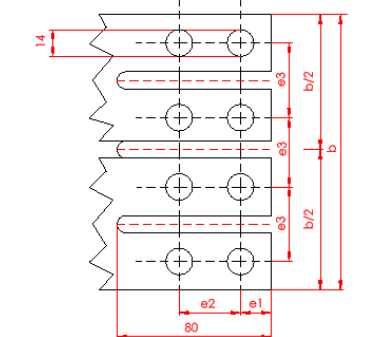
Unless otherwise specified in the electrical design, the measurements from the ends of the bars to the base or ceiling should be followed according to Table 2.

Table 2 – Distances between the connection point and the ceiling/base

Gauge	1 cable per phase (mm)	2 cables per phase (mm)	3 cables per phase (mm)	4 cables per phase (mm)	5 cables per phase (mm)	6 or 8 cables per phase (mm)
6	100	100	100	-	-	-
10	100	100	100	-	-	-
16	150	150	150	-	-	-
25	150	150	150	-	-	-
35	150	150	150	-	-	-
50	150	150	150	-	-	-
70	150	170	200	-	-	-
95	180	180	215	-	-	-
120	215	215	230	260	-	-
150	255	255	280	305	-	-
185	305	305	330	360	400	450
240	360	360	380	400	450	500
300	380	405	460	480	530	580
400	460	510	560	600	600	600
500	485	560	600	600	600	600

Source: Pólux Indústria Eletromecânica Ltda

Table 3 – Connection layout

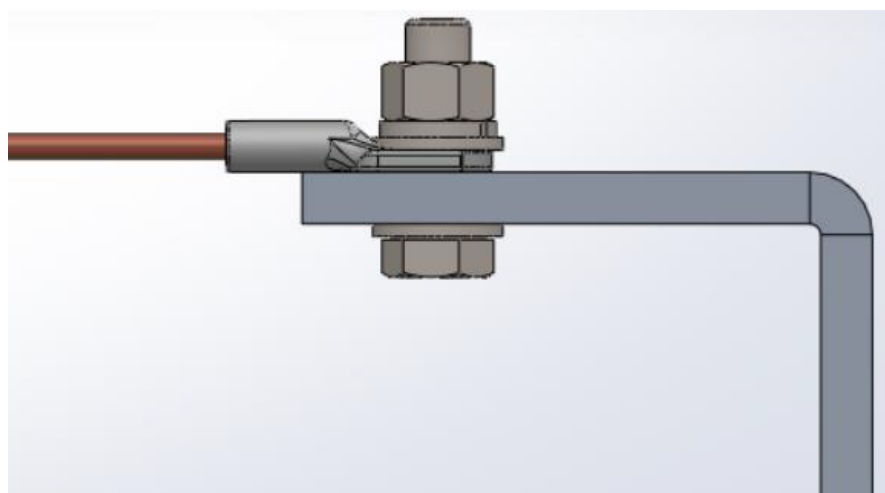
Form	Dimensional figure	b (mm)	d (mm)		Screw	e1 (mm)	e2 (mm)	e3 (mm)
			Through hole	Thread				
1		12	5.5	M5	M5	6	-	-
		15	6.6	M6	M6	7.5		
		20	9.0	M8	M8	10		
		25	11	M10	M10	12.5		
		30	11	M10	M10	15		
		40	14	M12	M12	20		
		50	14	M12	M12	25		
2		25	11	M10	M10	12.5	30	-
		30	11	M10	M10	15	30	-
		40	14	M12	M12	20	40	-
		50	14	M12	M12	20	40	-
		60	14	M12	M12	20	40	-
3		80	14	M12	M12	20	40	40
		100				20	40	50
		120				20	40	60
4		160	14	M12	M12	20	40	40
		200						50

Source: Pólux Indústria Eletromecânica Ltda

The transformer connection can be made using cables, and for this it is necessary to check if the busbar is clean and free of corrosion or oxidation (if necessary, clean the contact areas with a wire brush or a non-abrasive cloth). Ensure that the connection points on the busbar are accessible and prepared to receive the tubular terminal.

Use the torque wrench to tighten the mounting screws, following the torque specified in this manual for each gauge. Figure 5 below shows how the connection between the busbar and the connecting cable should be.

Figure 5 – Demonstration of the transformer busbar connection with the cable.



Source: Pólux Indústria Eletromecânica Ltda

For installation after long periods of storage, the contact surfaces should be polished with a fine steel brush or fine sandpaper along with non-acidic lubricating petroleum jelly, which will also help prevent corrosion of the aluminum.

4.2. Special conditions

Special operating, transport, or installation conditions include those that may require special construction, revision of nominal values, or special care during the transport, installation, or operation of the transformer.

Examples of these special conditions are:

- Installation at altitudes above 1000 meters above sea level and temperatures above 40°C;
- Exposure to excessive moisture, saline atmosphere, gases or smoke that are harmful to the equipment;
- Exposure to harmful dust such as iron ore dust, sulfur, etc.;
- Exposure to explosive materials in the form of gases or dust;
- Insulation requirements differ from those specified for the equipment;
- Limited installation space;
- Transportation, installation and storage under precarious conditions;
- Risk of abnormal vibrations, seismic tremors and occasional shocks.

These factors should always be checked in order to obtain optimal performance and as a preventive measure against accidents or damage to the equipment. Exposure to these factors will result in a loss of transformer efficiency.

4.2.1. Operating altitude

Pólux low and medium voltage transformers are designed and manufactured in accordance with applicable standards for installations up to 1000 meters above sea level.

At higher altitudes, the transformer will have reduced operating capacity due to the reduction in the dielectric strength of the air. Therefore, a correction factor, as shown in Table 4, must be used.

Table 4 – Correction of air dielectric strength by altitude.

Altitude (m)	Correction factor
1000	1.00
1200	0.98
1500	0.95
1800	0.92
2100	0.89
2400	0.86
2700	0.83
3000	0.80
3600	0.75
4200	0.70
4500	0.67

Source: NBR

4.3. Basic installation requirement

Dry-type transformers should be installed on a properly leveled and sturdy surface to support their weight. When transformers are fitted with wheels, ensure that the equipment is evenly supported at all points on the base to guarantee stability and prevent deformation. The following factors should be carefully considered during transformer installations:

- There must be a minimum space of 0.5 m between transformers and between them and walls or fences, providing minimally adequate ventilation.

Pólux dry-type low and medium voltage transformers are designed and manufactured to operate at a maximum ambient temperature of 40°C and a maximum altitude of 1000 meters. If the customer has special application requirements, these must be communicated in advance during the

technical/commercial proposal process so that the non-standard conditions can be evaluated by the product engineering team.

The installation environment must provide adequate ventilation for the proper functioning of the equipment, as temperatures exceeding the designed capacity may reduce its power. Therefore, it is important that the air inlets are located at the bottom and the outlets on the opposite wall at the top, with sufficient openings for minimum circulation according to Equation 1:

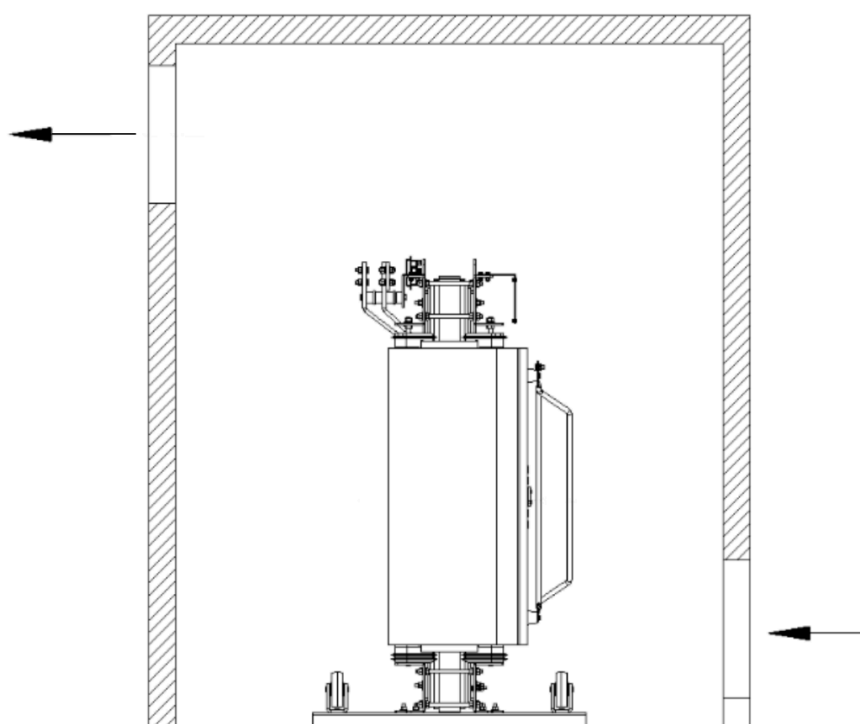
$$F = 2,5 \times P_s$$

Given that:

P_s = transformer loss in kW;

F = Airflow in m^3/hour .

Figure 6 – Air intake for natural ventilation.



Source: Pólux Indústria Eletromecânica Ltda

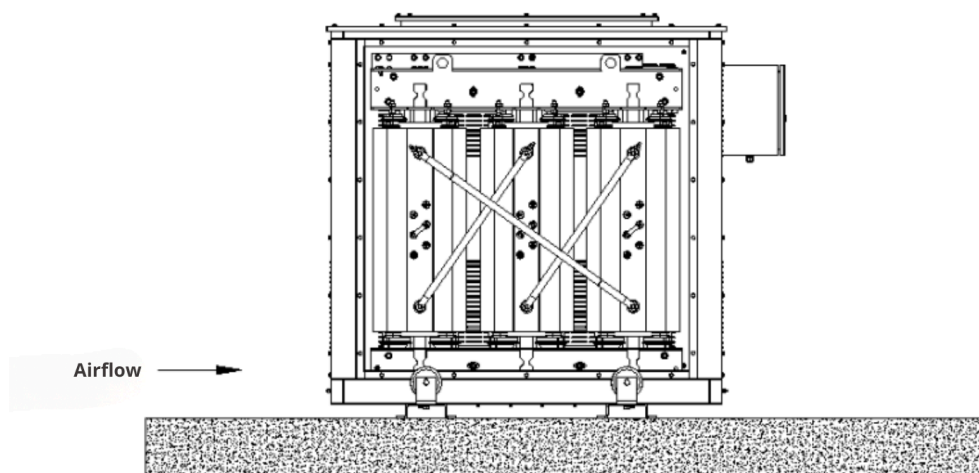
In cases where natural ventilation is insufficient, fans can be installed to increase airflow in the room as shown in Figure 6, or preferably, air conditioning can be adopted in the room where the transformer will operate.

If air conditioning is installed in the electrical room where the transformer is located, do not point the air conditioning equipment directly at the transformer to avoid condensation. This contact with water can cause the transformer to burn out.

4.4. Blocking airflow from the protective enclosure

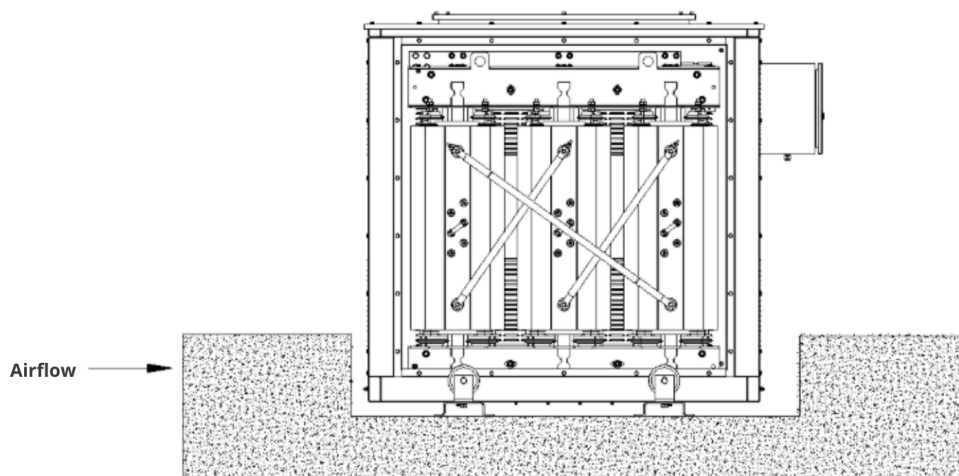
The transformer must be installed in an appropriate location (according to the degree of protection), with sufficient ventilation for proper cooling. Do not obstruct air circulation in the lower part of the protective enclosure.

Figure 7 – Unobstructed airflow.



Source: Pólux Indústria Eletromecânica Ltda

Figure 8 – Obstructed airflow.



Source: Pólux Indústria Eletromecânica Ltda

4.5. Noise level

The final noise level of the equipment is directly related to how strictly the installation precautions are followed. By adopting the appropriate preventive measures, it is possible to achieve the noise levels stipulated in the standards. Some relevant points are listed below.

- Before connecting the transformer to the electrical network, ensure that the tap changer panel is configured for the correct nominal voltage, according to the equipment specifications;
- To minimize noise propagation, avoid installation in locations with acoustic resonance, such as corners, cubicles, and triangular-shaped rooms;
- If possible, choose an installation location away from areas where the noise would cause the most discomfort, such as offices or reception areas;

- There is also the option of using materials for soundproofing the area where the transformer will be installed. This item should be verified with a specialized company.
- For installation in structural framing, walls, ceilings, or columns, flexible shims can be used to support the transformer, acting as "noise dampeners";
- Check that all four wheels of the transformer are firmly positioned on the ground.

4.6. Distances required for operation

The installation of transformers must be carried out in accordance with technical standards, respecting the minimum dielectric distances indicated in the table below. These distances are essential to avoid electrical discharges and ensure the safety of the installation.

Table 5 – Minimum distance between transformer and other structures.

Equipment voltage class [kV]	Atmospheric impulse voltage [kV]	Minimum spacing with insulation [mm]	Minimum spacing without insulation [mm]
1.1	-	20	25
3.6	20	30	40
7.2	40	35	45
	60	50	65
15	95	80	130
	110	100	150
24.2	125	130	170
	150	160	200
36.2	150	160	200
	170	200	240
	200	250	300

Source: Pólux Indústria Eletromecânica Ltda

During cleaning, isolate the underside of the busbar to prevent particles from falling onto the transformer coils.

Electrical connections must be made according to the equipment's specific diagram and the nameplate data. Verify the compatibility of voltage, current, and other characteristics with the system. Use flexible terminations to accommodate the thermal expansion and contraction of the cables, avoiding mechanical stress.

Size the cables and tighten the connections according to technical standards to avoid overheating. Pólux transformers have standardized terminal markings. Refer to the item's dimensional drawing.



BEFORE OPERATING THE TRANSFORMER, RETIGHTEN ALL ELECTRICAL AND MECHANICAL CONNECTIONS.

The thermal protection circuit, if present, must be connected according to its wiring manual.

The grounding grid must be connected to the appropriate terminals using copper cable with the correct cross-section.

4.6.1. Busbar connection

Once the busbars have had their surfaces cleaned, they will be ready to be connected.

- **Aluminum-to-Aluminum Connection:** The transformer terminals and the busbars to be connected must receive identical treatment, preparing the surface as previously mentioned;
- **Aluminum-Copper Connection:** When making a connection between copper and aluminum materials (busbars), it is recommended that these busbars have a chemical treatment (tin/silver). In addition to this

treatment, bare copper plates or bimetallic elements can also be used to improve the connections.

5. Protection and control system

The transformer must be protected against overloads, short circuits, and voltage surges, using circuit breakers, disconnectors, surge arresters, and other devices defined by the standard, which must be provided by the person responsible for the installation or requested when purchasing the equipment.

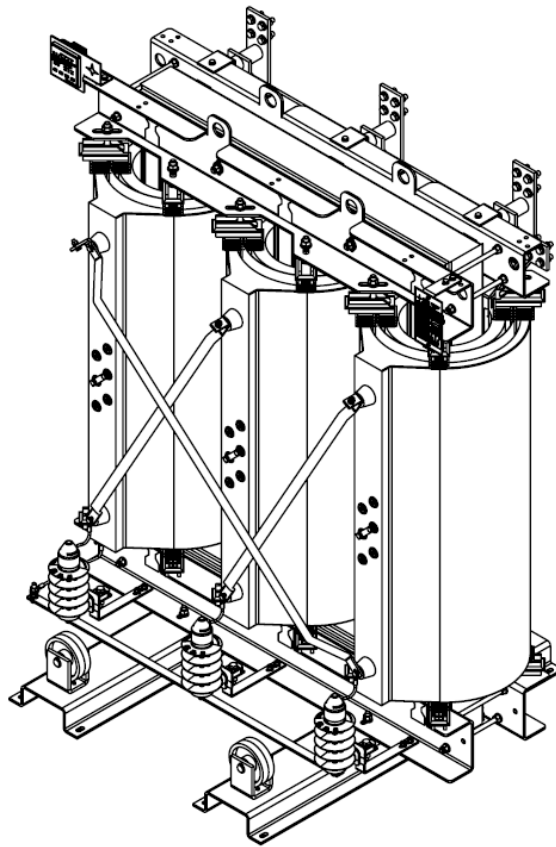
Prior to energizing, all these components must be thoroughly tested in accordance with the standards applicable to each of them.

5.1. Surge arresters

When surge arresters are installed near the active part of the transformer, their ground terminals cannot be connected to any grounding points located on the top of the transformer. They must be grounded in parallel to the transformer structure, i.e., individual grounding.

In the case of transformers that have factory-installed surge arresters, the equipment connection to ground will already be made. Simply check the torque applied to the connectors and connect the terminal intended for the phase to the corresponding phase of the transformer.

Figure 9 – Demonstration of a transformer with a surge arrester.



Source: Pólux Indústria Eletromecânica Ltda

5.2. Temperature monitoring

The monitoring system analyzes temperature variations in the winding and protects the transformer in case of excessive temperature rise due to overload, short circuit, or any other anomaly. It is important to note that this protection does not prevent a reduction in the transformer's lifespan if the cooling air temperatures are not maintained within the specified limits.

The temperature monitoring system for Pólux transformers consists of platinum thermistors (PT-100), in accordance with the IEC 60751:2008 standard, and a monitoring device with contacts for alarm, shutdown and serial communication port (when requested), using the Modbus protocol for connection to a supervisory system.

At least one PT-100 thermistor is installed in each of the coils. The alarm and shutdown functions are parameterized in the monitoring device, and the parameterized values can be found in the protection circuit diagram. By default, the PT-100s are sent in a three-conductor circuit and are fixed to the top of the winding. The transformer's thermal protection system is parameterized at our factory, requiring no additional field adjustments.

If the customer prefers, a temperature control relay can be installed to protect the transformer against high temperatures. The thermal protection relay used is the EP3 manufactured by Electron, which monitors up to 3 temperature channels; in the case of a three-phase transformer, it monitors the temperature of all 3 coils.

6. Commissioning

After the transformer is positioned at its operating base and before its installation/energization, field electrical tests must be performed to certify the operational integrity of the equipment.

The company responsible for these services must provide:

- Specialized team;
- Instruments that have been properly calibrated and have a valid calibration certificate.

6.1. List of instruments

- Transformer ratio meter;
- Ohmic resistance meter;
- Insulation resistance meter;

- Multimeter;
- Clamp meter;
- Thermohygrometer.

6.2. List of tests and verifications

Tests:

- Transformation ratio in all phases and all taps of the transformer;
- Ohmic resistance of the windings in all phases and all taps of the transformer;
- Insulation resistance of the transformer windings;
- Insulation resistance of all wiring in the transformer control panel, if applicable.

Verifications:

- Evaluate the temperature monitor programming;
- Perform a simulation of the temperature monitor's contact operation;
- After powering up the control panel, check the direction of rotation of the fan motors, circuit breaker settings, and the panel heating system, if applicable.

Note: Test records must be dated and signed by the person responsible for their execution. Without such a signature, they will not be considered valid by the manufacturer or its representative. All records must be filed and, if necessary, made available to the manufacturer for consultation and verification of results, as per the information contained in the Warranty Terms.

6.3. Acceptance criteria

Table 6 – Reference values for acceptance criteria.

Item	Description	Reference values
1	Transformer transformation ratio	$\pm 0.5\%$
2	Ohmic resistance of transformer windings	Maximum 5% above the factory measurement value.
3	Insulation resistance of transformer windings	HV-Earth: $\geq 1\text{M}\Omega/5\text{kV}$ HV-LV: $\geq 1\text{M}\Omega/5\text{kV}$ LV-Earth: $\geq 1\text{M}\Omega/2\text{kV}$
4	Resistance of the insulation of all the wiring in the control panel.	$\geq 0.5\text{ G}\Omega/500\text{Vdc}$
5	Temperature monitor program	According to the topographic diagram
6	Perform a simulation of the transformer temperature monitor's operation.	Operation of contacts as per diagram

Source: Pólux Indústria Eletromecânica Ltda

6.4. Painting

The paint systems of the protective casing, hardware, and core must be perfectly intact to guarantee the protection intended by the equipment design.

To ensure the integrity of the paint system, any damage caused during transport and/or assembly should be repaired as soon as possible.

6.4.1. Visual inspection

- Perform a visual inspection to identify all damaged areas or areas requiring repair;
- During the inspection, consider that the repair should cover not only the specific area of the damage. A 20 cm diameter circle around the damaged point should also be considered for the repair.

6.4.2. Surface preparation and painting

The original paint job uses powder coating, but touch-ups have to be done with liquid paint. Therefore, in areas where there has been damage, there may be a difference in visual appearance due to the texture of the powder coating, which liquid paint will not perfectly reproduce.

If touch-ups are needed on the paintwork, the following procedures should be followed:

- Using adhesive tape, mark off the area of the transformer surface that will be touched up;
- Using fine sandpaper, remove the paint from the outlined area;
- To remove the RTV, use a plastic brush;
- Clean the area with solvent or alcohol;
- Dry the area to be touched up;
- Apply a coat of finishing paint, as specified by Pólux, using a brush or air gun;
- If the equipment is outdoors, cover it with plastic to protect it from sun or rain for 24 hours to ensure the paint dries properly.
- Silicone paint repair (RTV):
 - a. Using a paintbrush or roller, apply a coat of RTV paint, duly approved by Pólux;
 - a. If the equipment is outdoors, cover it with plastic to protect it from sun or rain for a minimum of 72 hours to ensure the paint dries properly.

Note: The drying times indicated above assume an ambient temperature of 20°C and use materials recommended by Pólux. For paints from other brands, consult the supplier's technical data sheet.

7. Energization

Energizing Pólux transformers is an extremely important procedure and must be carried out by a qualified professional, respecting all applicable technical and regulatory standards. Before energizing the equipment, in addition to verifying the installation according to safety standards, the following points must be observed:

- **Connections and fastening:** Check that all connections have been made correctly and that cables, busbars or any connecting elements are fixed and properly supported, avoiding mechanical stress on the transformer terminals;
- **Screw torque:** Check the connections and torque of the contact screws according to Table 1 of this manual;
- **Temperature sensors:** Check the integrity of the temperature sensors (when applicable) and ensure they are correctly connected to the terminals of the protection relay. Confirm that the supply voltage to the protection relay is adequate. If in doubt, consult the monitoring device catalog supplied with the transformer.
- **Foreign objects:** Ensure that there are no foreign objects (nuts, bolts, washers, tools, etc.) trapped between the coils, between the coils and the core, or between the transformer and the protective enclosure (when provided);

- **Cable glands:** In enclosures with cable glands, check that they are properly tightened until they make contact with the cables passing through them;
- Evaluate the results obtained from the field commissioning electrical test reports and compare them with the factory test reports;
- Assess whether the tap position is in accordance with the system voltage condition;
- For the operation of transformers in parallel, verify that the connection has the correct polarity;
- **Grounding connection:** Confirm that the transformer is securely connected to the grounding circuit via the connector installed on its base.



To prevent the formation and circulation of currents in the grounding system, only one point on the transformer should be connected to ground.

After verifying all the points above, the energizing of the Pólux transformer must follow these procedures:

1. Energize the transformer when it is unloaded;
2. Check temperature readings on the monitoring device (when installed);
3. Always keep a safe distance from the energized transformer.

Strictly following these procedures will ensure the safety and proper performance of the transformer during operation.

8. Putting the transformer into operation

Once the transformer is connected to the high-voltage system:

- Voltage will be applied to the transformer under no-load conditions and observed for one hour. No anomalies should occur during this time period.
- The voltage should be measured at the high-voltage and low-voltage terminals to verify that it meets the values required for the proper functioning of the transformer;
- Apply the load progressively until the rated power is reached and check the transformer temperature.

9. Derivation/Voltage Change

Some dry-type transformers are equipped with a panel with terminals on the high-voltage coils that allow for tap changes to regulate the output voltage. This activity should only be performed with the transformer de-energized and properly grounded.

Every time the panel is handled, it is necessary to repeat the ohmic resistance test of the windings in the new working position defined. The values obtained should be evaluated and compared with the measurements performed in the factory tests.

10. Maintenance

Dry-type transformers manufactured by Pólux are designed to require little or no maintenance. However, to ensure optimal performance and extend

their service life, we recommend conducting periodic visual inspections every twenty-four months.

10.1. Maintenance Items

- **Visual inspection of the site:** Conduct a thorough visual inspection of the environment where the transformer is installed. Check for signs of deterioration, dust buildup, or other contaminants that could affect the equipment's operation.
- **Inspection of torque seals:** Visually check the torque seals on the connecting bolts. Ensure that all bolts are securely tightened and that there are no signs of loosening or corrosion;
- **Cleaning the ventilation channels:** Regularly clean the ventilation channels between the transformer coils. Obstruction of these channels can lead to overheating and compromise performance.
- **Verification of connection terminals:** Use a thermal imaging camera to inspect the temperature at the connection terminals. Early detection of hot spots can prevent catastrophic failures. Check that the terminals are free of oxidation and properly connected;
- **Operation of the thermal protection system:** Test the thermal protection system, when applicable, to ensure it is operating correctly. Check the temperature sensors and protection circuits. Any anomalies should be corrected immediately.
- **Electrical connections:** Ensure all electrical connections are secure and free from corrosion. Inspect cables and busbars for signs of wear or damage.

- **Mechanical components:** Check all mechanical components, such as supports and fasteners, to ensure they are secure and show no signs of excessive wear;
- **Maintenance documentation:** Keep a detailed record of all inspections and maintenance performed. This includes date, time, points checked, actions taken, and observations. This history is crucial for tracking transformer performance over time and planning future preventive maintenance.

Following these recommendations will help ensure that Pólux transformers continue to operate efficiently and safely. If you have any questions or require technical assistance, please contact Pólux technical support for expert guidance.

Table 7 – Operational abnormalities.

Item	Defect	Probable cause	Corrective action
1	Overheating at the HV and LV terminals, connection points, and switch panel	Bad connection	- Clean contact areas; - Retighten nuts and screws.
2	Transformer overheating	Supply voltage higher than expected	- Check the voltage.
		Overload exceeding expectations	- Reduce the load; - Increase the refrigeration airflow.
		Insufficient cooling air circulation	- Clean the cooling air ducts.
		Cooling air temperature above the expected temperature	- Reduce the load; - Increase the refrigeration airflow.
3	Protection relay operating (alarm and/or trip)	Transformer overheating	- See item 3 above.
		No power supply to the relay	- Check the supply voltage at the relay; - Check that the relay is functioning properly; - Check the protection circuit (relay + temperature sensors).
4	Excessive noise	- Supply voltage higher than expected; - Uneven installation of the transformer base; - Resonance with surfaces surrounding the equipment.	- Check that the voltage is correct and adjust to the most appropriate tap. - Check for any loose metal surfaces (panels, cabinets, ducts, doors, etc.) that could cause vibrations.
		Transmitted resonances through the connections	- Installation of flexible components between the transformer terminals and the installation conductors.

Source: Pólux Indústria Eletromecânica Ltda

If the abnormalities persist after applying the suggested corrective actions, or if other abnormalities not described in Table 7 are observed, contact Pólux's after-sales service immediately.

11. Cleaning

An important factor for the optimal functioning of this type of transformer is its constant and efficient cleaning to prevent alterations in its dielectric characteristics. For this reason, we will indicate cleaning procedures for the following types of impurities:

Table 8 – Cleaning procedures

Type of dirt found	Procedure used
Dry powder in general	1 and 4
Wet powder	3 and 4
Sea breeze	1 and 4
Metal powder	1 and 4
Oils in general	2, 3 and 4
Graphite or similar	1 and 4

Source: Pólux Indústria Eletromecânica Ltda

1. Using a vacuum cleaner and a dry cloth, remove the dust deposited on the transformer. Then, use a vacuum cleaner with an appropriate nozzle to remove dust residue and clean the ventilation channels of the coils and between the coil and the core. Finally, use a clean, dry cloth to remove any remaining residue from the coils, especially around the terminals and insulators;
2. Using a cloth dampened with isopropyl alcohol, remove impurities from the core, hardware, and coils. Check if the channels are clogged. If the impurities in the channels are dry and loose, proceed with procedure (1) for this cleaning. Otherwise, identify the existing dirt and contact the factory to determine the best procedure;
3. Using a cloth dampened with water containing a small amount of ammonia or alcohol, remove all impurities from the transformer body.

The cleaning can be supplemented using one of the previous procedures depending on the type of dirt to be removed;

4. The final step should always be to use a clean, dry cloth, wiping the entire surface, especially around the connection terminals.

12. Special protection class for dry-type transformers

Dry-type transformers with higher protection ratings (IP 40/41/44/54/55) have protective devices with filters and/or other special equipment, which also require specific care for the correct operation of the equipment.

To achieve the best results in terms of transformer performance and longevity, preventive maintenance must be carried out regularly at fixed intervals and performed by a qualified technician. This interval for transformers with a higher degree of protection depends on factors such as the intensity of use of the equipment (operating conditions) and the environmental conditions present at the installation site (ambient temperature, ventilation, presence of dust, etc.).

It is recommended to start preventive maintenance every three months, and subsequently adjust the time between maintenance sessions as results indicate the need to reduce or increase their frequency. It is also recommended to keep a detailed record of the preventive maintenance performed. These records serve as proof that the maintenance was carried out and can help identify the causes and possible reasons for alarm activation and other field occurrences.

12. 1. Operation of the fans and exhausters

When applicable, assess the correct functioning of the motor fans and exhaust fans, in order to ensure that they are all rotating in the correct direction and that they are performing their proper functions (air intake or air exhaust).

12.2. Cleaning the air intake and exhaust ventilation filters

Remove the protective covers from the air intake filters located in the ventilation ducts or on the sides of the protective housing. After removing the filters, proceed with cleaning them or replacing them with new ones. Only replace the filter with a similar one. This ensures heat exchange with the external environment, guaranteeing the perfect functioning of the equipment. The amount of dirt accumulated in the filters is a fundamental factor in determining the correct time between preventive maintenance. Initially, it is recommended that cleaning be performed every three months; depending on the condition of the filter during this period, the interval may be readjusted. After cleaning or replacement, replace the filter in its proper place.

Below is a step-by-step guide on how to proceed with cleaning:

- a. Remove the filter support grids;
- b. Wash or scrub the filters with clean, pure water;
- c. Allow to dry (Do not assemble while the grid is damp);
- d. Add the clean filters;
- e. Install protective grilles.

For transformers with IP54 and IP55 protection ratings, maintenance of the ventilation filters can be carried out from the outside of the transformer's protective enclosure. However, for transformers with protection ratings between IP40 and IP44, all filter maintenance must be carried out with the transformer de-energized, as access to the filters is from inside the protective enclosure.

13. Safety and environment

Pólux is committed to protecting the environment, using the most suitable materials in the manufacture of our transformers. When a transformer reaches the end of its useful life or when any of its components need to be replaced, it is essential that disposal is carried out in accordance with current safety procedures and environmental regulations. Similarly, the packaging that protects the transformer during transport must be disposed of appropriately.

If you have any questions about proper disposal, please consult our quality engineering department for detailed guidance.

Pólux believes that we should all share the commitment to preserving the environment. It is crucial to prevent contaminating materials and used components from being improperly disposed of, as many of these materials can be recycled, preventing the contamination of natural water and soil sources and protecting public health.

Furthermore, we emphasize the importance of adopting sustainable practices throughout the entire transformer lifecycle. This includes reducing resource waste during manufacturing, optimizing energy use, and implementing environmental management systems that ensure compliance with environmental legislation and industry best practices.

Pólux encourages its customers and partners to actively engage in sustainability initiatives, promoting the reuse of materials and recycling whenever possible. Furthermore, it is recommended to conduct periodic training on environmental and safety practices for all employees involved in the handling, installation, and maintenance of transformers, ensuring they are aware of best practices and procedures to follow.

By adopting these measures, we are not only fulfilling our legal and ethical responsibilities, but also contributing to a more sustainable and healthy future for generations to come. Together, we can make a difference in preserving our planet.

14. Warranty Terms

Before putting this equipment into operation, it is essential to perform commissioning, according to the information contained in the project and/or nameplate. This procedure aims to verify the condition of the equipment after transport and installation, ensuring that all connections are tightened and that this warranty document is read in its entirety. Failure to observe this warning releases us from any liability for resulting damages.

- The warranty period for Pólux products will be 12 (twelve) months, starting from the delivery of the product when this is the responsibility of the manufacturer, or starting from the collection of the product at Pólux's premises when it is the responsibility of the customer.
- Any repairs can only be carried out at the Pólux factory in Jaraguá do Sul, Santa Catarina, or by a qualified technician previously authorized by the company.
- During the warranty period, all repairs and parts replacements will be carried out free of charge by Pólux if a manufacturing defect is proven.

The customer is responsible for delivering and picking up the equipment at the factory. Transportation costs or personnel travel to the site are not covered by the warranty and are the customer's responsibility.

14.1 The following equipment is not covered by the warranty

- That suffered damage during transport, when this is the customer's responsibility;
- That have been stored or handled improperly or in an unsuitable location;
- They were poorly installed, not following the technical standards applicable to the installation of electrical equipment;
- Whose power supply network is not within the specified limits;
- Which were repaired by a person who was not qualified and not authorized by Pólux;
- That have been modified by third parties;
- That have been overloaded, suffered short circuits, overvoltage, overcurrent, lightning strikes, or any other anomaly during transport or application;
- That are being used inappropriately;
- Whose connection terminals are loose, oxidized, or have poor contact;
- That are in environmental conditions or exposed to aggressive agents not foreseen in the client's specification;
- That have not undergone regular preventive maintenance.

The assessment of these requirements rests with Pólux's technical team, based on information provided by the client and after analysis of the damaged equipment. The client may be held responsible for the costs involved in the service provided by Pólux.

After the warranty period ends, all transportation expenses and risks are the customer's responsibility.

This warranty applies only to the equipment supplied, and Pólux is not liable for damages to persons, third parties, other equipment or facilities, lost profits, or any other incidental or consequential damages.

This warranty does not cover parts or components subject to normal wear and tear, such as fuses, lamps, thyristors, transistors, power diodes, varistors, contacts and similar items, as well as components whose lifespan under normal use is shorter than the warranty period.

Power factor correction equipment requires special care. Measurements are recommended for proper sizing and to check for disturbances (harmonics) in the network. The warranty will only be granted if the installations maintain the same measurement characteristics as at the time the equipment was sized.

When this equipment is not sized by Pólux, the company is only responsible for manufacturing it according to the specifications provided by the client in the commercial proposal, contract, purchase order, and/or request.

Pólux is not responsible for any damage caused to the customer's plant before or after the installation of equipment manufactured by the company.



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